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G. C. SAVAGE, M.D., Editor and Publisher.

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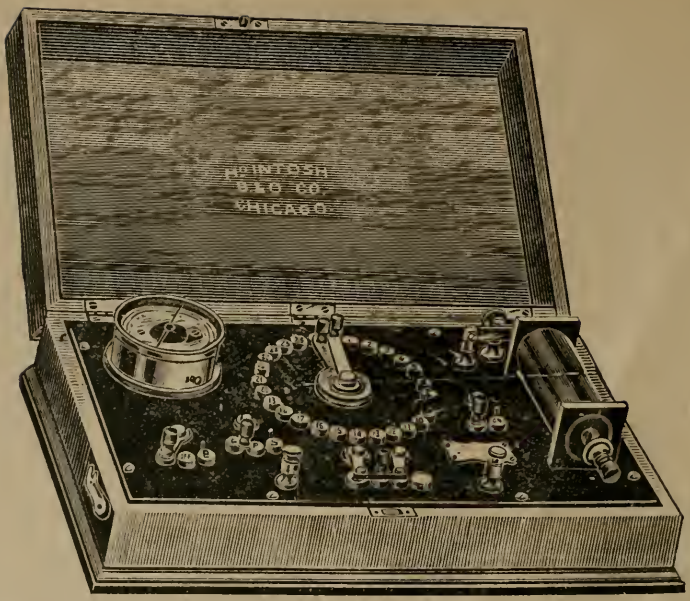

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THE
OPHTHALMIC RECORD.

VOL. IV. APRIL, 1895. No. 10.

THE FUNCTIONS OF THE OBLIQUE MUSCLES. ESPECIALLY AS THEY ARE RELATED TO OBLIQUE ASTIGMATISM.*

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The common purpose of all the extrinsic ocular muscles is the production of binocular single vision, in obedience to the law of corresponding retinal points. The recti muscles are designed to control the visual axes, while the obliques are concerned with the corneo-retinal meridians. In model eyes a plane may be constructed so as to cut the macula and the nodal point of each eye and that point of the object to be fixed. The superior and inferior recti must keep the two visual axes in this plane, while the external and internal recti must direct them so that they may intersect at the point to be fixed. Since, in all eyes free from oblique astigmatism, all other visual lines bear a definite relationship to the visual axis, they may be ignored in any study of the ocular muscles. If the recti muscles, in accomplishing the purpose of their existence, effected no other change of the eyes, there would be no need for oblique muscles in eyes not having oblique astigmatism. The three axes of rotation are at right angles to one another, their point of intersection the nodal point—the center of retinal curvature. The

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lateral recti muscles if properly attached to the globe, will rotate it only on the perpendicular axis; the superior and inferior recti, could not, if unopposed, effect the rotation of the eye on its transverse diameter, and hence would cause a form of double vision in spite of the fact that they would keep the visual axes in the normal plane. In order to insure binocular single vision other muscles are needed besides those that govern the visual axes, and these muscles are the obliques.

If there were no such condition as astigmatism, or if the principal meridians in astigmatic eyes were always vertical and horizontal, there would be but one function for the oblique muscles, and that function would be the keeping of the naturally vertical meridians of the corneas parallel, and their study would be greatly simplified. The prime object of this paper, however, is to show that the obliques have another and more complicated function to perform in many cases. Taking causes into consideration we may say that the one function of the obliques is simple while the other is complicated.

THE SIMPLE FUNCTION OF THE OBLIQUES

is keeping the naturally vertical meridians parallel. The need for this exists in all eyes, whatever may be the state of refraction other than oblique astigmatism. Even in oblique astigmatism equal in amount in the two eyes and the meridians of greatest curvature parallel, only the simple function is performed by the obliques. The necessity for this function of the obliques resides mainly in the action of

THE SUPERIOR AND INFERIOR RECTI,

which is faulty in all cases, because of the course of these muscles and their attachment to the globe. When the inferior recti are called upon to direct the visual axes below the horizontal plane of the two eyes, they, at the same time, tend both to converge these axes and to rotate the eyes so that the naturally vertical meridians would diverge above. To counteract

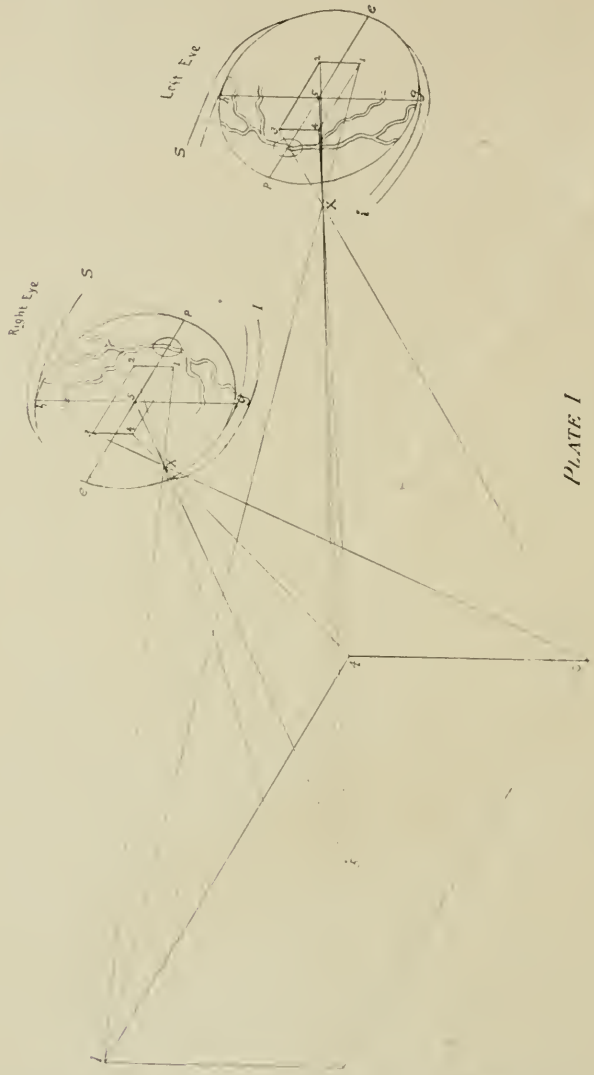
this latter tendency the superior obliques are thrown into a state of activity and the parallelism of the vertical meridians is maintained. When the visual lines are to be directed above the horizontal plane, by contraction of the superior recti, these muscles, besides tending to converge the axes, also tend to converge the vertical meridians above, to counteract which the inferior obliques are brought into a state of activity and thus parallelism is preserved.

If the tendons of the internal and external recti attach themselves, in greater part, below the horizontal plane of the eye, these muscles in adducting and abducting the eyes would tend to revolve them so that the vertical meridians of the corneas would diverge above. This tendency would be counteracted by the superior obliques. Should the lateral muscles be attached to the globe, mainly above the horizontal plane, adduction and abduction would be associated with a tendency to converge the vertical meridians above, which would be prevented by the action of the inferior obliques. It is probable that the one or the other error of attachment of the internal and external recti is not uncommon.

Thus it is seen that, with every contraction of the inferior recti, there must be an associated corrective contraction of the superior obliques; and, with every action of the superior recti, there is an accompanying and correcting action of the inferior obliques. Since we look down far more than we look up, the superior oblique muscles, in the same proportion, are made to do more work than the inferior obliques. Thus it is readily seen that the recti and oblique muscles, while opposing one another in action to a certain extent, work together in effecting binocular single vision, by keeping the two retinæ so related that the images fall on corresponding parts.

Plate I represents a pair of eyes that are non-astigmatic, or if astigmatism exists, the principal meridians are vertical and horizontal. These eyes are represented as looking at a rectangle.

The line *ep* across the right eye is the horizontal meridian and the line *gh* is the vertical meridian, while their points of inter-



section (5) is the macula. Similarly the line *ep* in the left eye represents the horizontal meridian and *gh* the vertical meridian, their point of intersection (5) being the macula. The vertical

meridian of the right and that of the left are parallel. Point 5 in the rectangle is the point of fixation. The line 5-5 from the macula of the right eye is the visual axis of that eye, and likewise the line 5-5 is the visual axis of the left eye. These intersect at point 5 of the rectangle.

According to the well-known law of refraction by curved surfaces, such as are now under consideration (non-astigmatic eyes), the rectangular object will throw a rectangular image on each retina, the size of which will bear a definite proportion to the size of the object. The nodal point of the right eye is x, through which all lines of direction from this eye must pass. The lower-inner corner of the image is thus connected with the upper right hand corner of the object by the line 1-1. In the same way the upper-inner corner of the image is connected with the lower right hand corner of the object by the visual line 2-2; and so on for the other corners of image and object. In like manner the corners of the rectangular image in the left eye may be connected with corresponding corners of the object by lines passing through the nodal point x of that eye. If the left eye should be excluded, the right eye would see the rectangle 1-2-3-4; if the right eye should be screened, the left would *see* the same rectangular figure. Both eyes together, in obedience to both the law of corresponding retinal points and the law of projection, would see the one common rectangle 1-2-3 4. The superior and inferior recti, in these eyes, have kept the visual axes in the normal plane; the external and internal recti have regulated their tension so that they have converged these axes to the point 5; and the superior and inferior obliques have kept the naturally vertical meridians parallel.

It has already been stated that the obliques have to perform only the simple function in oblique astigmatism when the meridians of greatest curvature are parallel and the degree of astigmatism is the same in the two eyes, and yet it would not be possible for such eyes to see the rectangle, held in position

shown in Plate I, as a rectangle. Let the meridians of greatest curvature be at 45° in the right and also at 45° in the left eye. As a result of the refraction of the astigmatic cornea of the right eye, the rectangular figure would throw a parallelogram image on the retina, the image inclining down and out. A parallelogram image would be thrown on the left retina also, and it would incline down and in. Looked at with either eye alone, the rectangle would be seen as a parallelogram inclined down and to the right. Looked at with both eyes it would be a parallelogram of the same shape and inclination as seen by each eye separately. The extrinsic muscles of these eyes have performed the same function as the muscles of the eyes shown in plate I, and with the same result, viz.: binocular single vision. The law of corresponding retinal points and the law of projection having full sway in both pairs of eyes, the one pair sees the figure as it is—a rectangle, while the other pair sees the same figure, when held in the same position, as a parallelogram leaning down and to the right. With the visual axes properly directed by the recti, and the vertical meridians kept parallel by the obliques, the two eyes are kept so related that the two images of the object looked at fall on harmonizing parts of the two retinæ and the object is necessarily seen as one, and of same shape as when seen with each eye separately.

In any state of refraction the relationship between corresponding points of the two retinæ is unalterable. It is well-known, that, taken as a whole, the nasal half of one retina, harmonizes with the temporal half of the other; and that all points of either retina bear a fixed—an unalterable—relationship to the macula and to the vertical and horizontal meridians. A retinal point in the nasal half of the right retina bearing a definite relationship to the macula and the vertical and horizontal meridians, must harmonize with a point in the temporal half of the left retina similarly located; and it can harmonize with no other retinal point, under any conditions.

THE COMPLICATED FUNCTION OF THE OBLIQUES

is necessary in oblique astigmatism, when the meridians of greatest curvature diverge or converge above. This is neces-

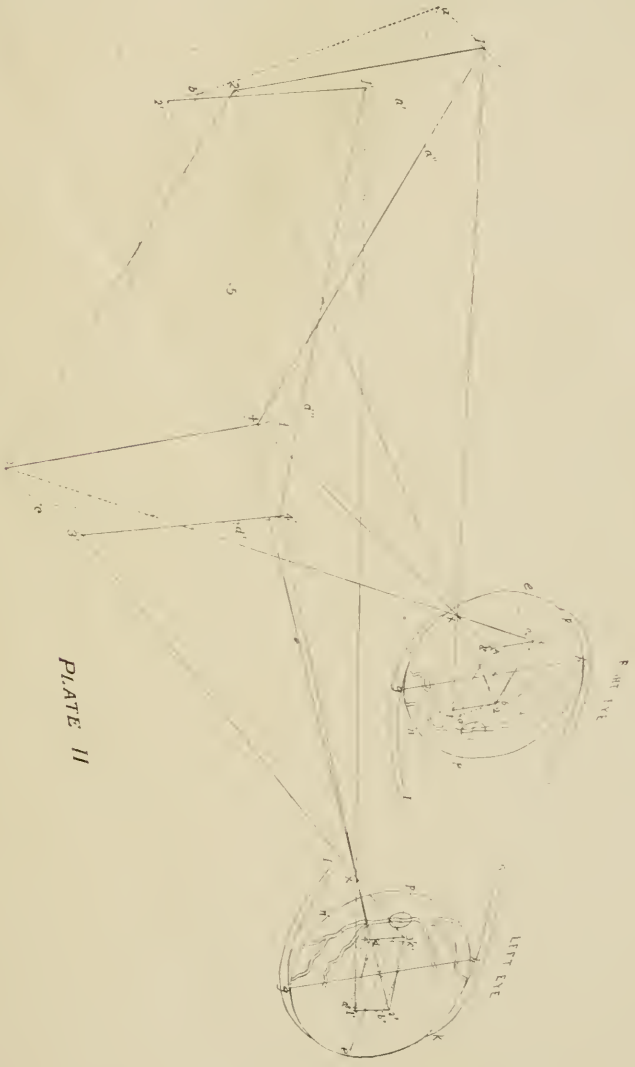


PLATE II

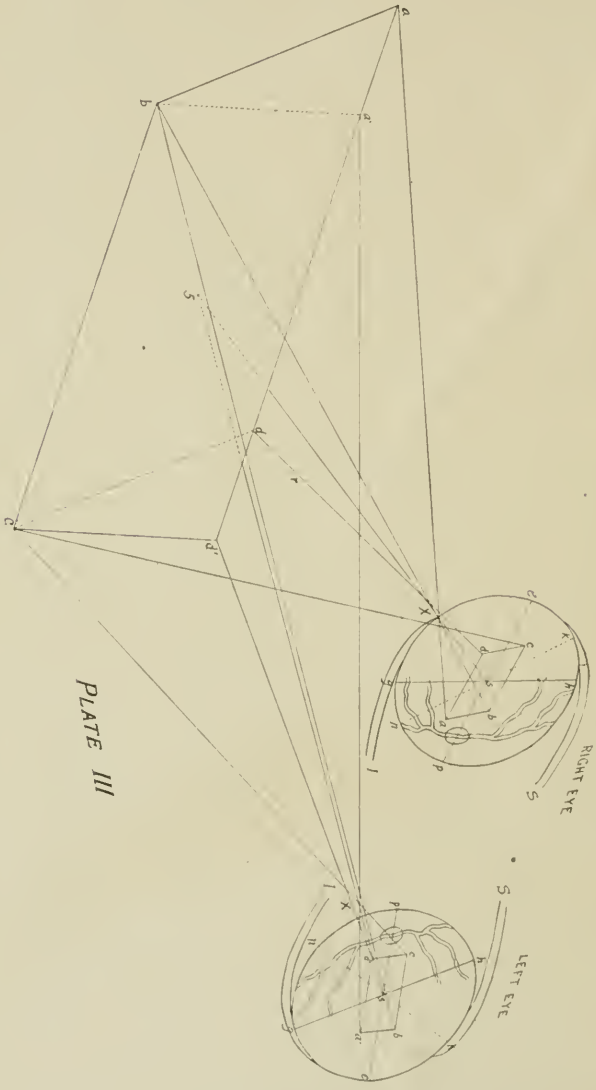
sary that they may bring harmonizing parts of the two retinæ under dissimilar images and thus insure binocular single vision.

But, as will be shown, the object, though seen as one, will be distorted.

Plate II may be taken for study. Both eyes have oblique astigmatism of the same kind and quantity. In the right eye the meridian of greatest curvature is at 135° and in the left at 45°. As set forth in a former paper, the refraction in oblique astigmatism is such as to make vertical and horizontal lines incline towards the meridian of greatest curvature. If the rectangular figure, represented in Plate I, be held in the same position before the eyes represented in Plate II, it could not be seen with either eye alone or with both together, as a rectangle. The rectangle shown in Plate I, when held before the right eye in Plate II, instead of throwing a rectangular, would throw a parallelogram, image on the retina. The same rectangle would also throw a parallelogram image on the left retina. The state of refraction of the right eye would make the distorted image lean down and toward the left, while the distorted image in the left eye would lean down and towards the right side. Cutting off the view of the left eye the law of direction would have full sway, while the law of corresponding points would be suspended. Since in one eye alone the law of direction is unalterable, all lines of direction must cross in the center of retinal curvature, and the right eye, with the parallelogram image leaning down and to the left, must see the figure casting the image, not as a rectangle but as a parallelogram leaning down and to the left. Screening the right eye while the left looks on the rectangle, it is seen, not as a rectangle, but as a parallelogram leaning down and to the right, the law of direction determining the shape of the figure seen by the left eye just as it fixed the shape of the figure seen by the right eye. Fig. 1-2-3-4 is what is seen with the right eye alone; fig. 1-′2-′3′-4′ is what is seen by the left eye alone. The moment these two eyes are allowed to look at the rectangular figure, the law of corresponding retinal points is brought into conflict with the

law of direction and the latter is modified by the former. There is no necessity for changing the visual axes when looking at the rectangle with these two eyes; but unless some change is effected in some way, each eye would see its own parallelogram leaning down and towards the opposite side. Instantly a change does take place in both eyes so that the two together see, not a rectangle nor a parallelogram, but a trapezoid with the longer side above. A clear understanding of what this change is and how it is effected may be had by a further study of Plate II. In the right eye is shown a dotted parallelogram *a*-*b* *c*-*d*, of precisely the same form as the parallelogram image 1-2-3-4, but in the former the upper and lower lines are parallel with the horizontal meridian. In the left eye also is shown a dotted parallelogram *a'*-*b'*-*c'*-*d'* of same form as the parallelogram 1'-2'-3'-4', with its upper and lower lines parallel with the horizontal meridian of this eye. The line *c*-*b* in right eye bears throughout the same relationship to the macula, the horizontal and vertical meridians of this eye, that the line *c'*-*b'* does to the same parts of the left eye and therefore correspond. The greater part of line *d*-*a* in the right eye also corresponds with the greater part of the line *d'*-*a'* in the left eye, the parts of these lines not corresponding being their extremities. But the line *c*-*d* in right eye nowhere corresponds with the line *c'*-*d'* in the left except at the points of beginning above; and the same is true of lines *b*-*a* and *b'*-*a'*, in their respective eyes. If the dotted parallelograms could be made to coincide with the parallelogram images, the result would be that the two eyes together would see the figure *a*-*b*-*c*-*d'*, a trapezoid with the longer side above. How this is effected is shown in Plate III, where each eye has been revolved on its visual axis by the superior oblique muscle so that the horizontal meridian is made parallel with the upper and lower borders of the parallelogram image, and thus as far as possible corresponding parts of the two retinæ are brought under the two dissimilar images, and the figure seen binocu-

larly is a-b-c-d'. The part of this trapezoid seen in common by the two eyes is a'-b-c-d, the part seen by the right alone is a-b-a',



and that seen by the left eye alone is d-c-d'. As will be seen the law of corresponding points has so modified the law of projection that the visual lines no longer have a common crossing

point. There is anarchy, so far as projection is concerned, in these eyes.

When the law of direction is interfered with, as a result of the conflict between it and the more imperious law of corresponding retinal points, the object seen is always in the position that it would have been in had the images primarily fallen on the parts of the two retinæ that have been rotated under them (by either the recti or the oblique muscles) in obedience to the supreme law of binocular single vision—the law of corresponding retinal points. The displaced images as a result of either natural or artificial means, cover areas of the two retinæ that do not correspond. In order to have binocular single vision retinal areas that do correspond, and of same shape and size as the images, must be brought under them. The object will be seen as though no rotation had taken place, as if the images had primarily fallen on these parts, in perfect obedience to the law of projection, although the lines of direction drawn from the images to the single object will not cross at the nodal point. In cases of decentration of the maculæ, and in displaced images by means of prisms, all lines of direction will cross at one point but that point will be above, below, to the outer or inner side of the true nodal point; while in oblique astigmatism, and when the axes of correcting cylinders are displaced, no three lines of direction cross at the same point.

In like manner a plate could be made showing how astigmatic eyes, with meridians of greatest curvature converging above, would see a rectangle distorted into a trapezoid, the longer side below. In each eye there would be a parallelogram image inclining down and out. To fuse these into a trapezoid the inferior oblique muscles would be brought into action in order, as far as possible, to bring corresponding retinal parts under dissimilar images, which is done the moment the obliques displace the horizontal meridians so that they become parallel with the upper and lower borders of the distorted images.

Imperfect as is binocular single vision in uncorrected oblique astigmatism, the meridians of greatest curvature either diverging or converging above, it could be effected in no other way than by a revolution of the eyes by the symmetric harmonious action of the oblique muscles. It is true that nature has one other method of preventing diplopia—mental suppression of one of the displaced images. It may be that amblyopia resulting from oblique astigmatism high in degree, and from insufficiency of the obliques, is more common than one would at first think. Certainly, if the obliques cannot do their proper work in effecting binocular single vision, in the first years of life, nothing is more reasonable than to suppose that amblyopia *ex anopsia* would develop. Who has not seen cases of amblyopia without being able to account for it?

The phenomena outlined in this paper can be demonstrated experimentally by any one who desires to prove all things; for he can produce in his own case, at pleasure, any form of astigmatism. But some may be ready to say that artificial astigmatism is one thing and natural astigmatism is another thing. This is true, but only in name. That 3 D. of artificial hypermetropic astigmatism is the same error of refraction as 3 D. of natural hypermetropic astigmatism is abundantly proved by the fact that each is thoroughly corrected by a plus three cylinder, axis properly placed. Either plus or minus cylinders may be used in the experiments, for the one is as capable of producing artificial astigmatism as the other; if the plus cylinders (3.00 D.) be used, the astigmatism produced has its meridian of greatest curvature at right angles to the axis of the cylinder, while the meridian of greatest curvature would correspond with the axis of the minus cylinders (3.00 D.) if they were used.

By either means it can be easily proved that in astigmatism of any kind (myopic, hypermetropic or mixed), whose meridians of greatest curvature diverge above, there is a necessity

for action on the part of the superior oblique muscles in order to prevent diplopia. This action, having its beginning in the earliest days of infancy and continuing during waking hours until the cause is corrected or one eye is lost, converges the naturally vertical meridians above. If the meridians of greatest curvature converge above, the images of all objects are so displaced in the two eyes as to throw into activity the inferior obliques so that diplopia may be prevented.

In astigmatism with the principal meridians vertical and horizontal the only eye-muscles brought into action, to in any way remedy the condition, are the ciliary muscles. In oblique astigmatism with the meridians of greatest curvature diverging above, there is the same state of ciliary strain to sharpen as much as possible the images, and there is also a necessary activity of the superior obliques so as to bring corresponding parts of the two retinæ under the oblique images, that there may be binocular single vision. Again in oblique astigmatism with the meridians of greatest curvature converging above, there is the ciliary strain for sharpening the images and there is also a consequent activity of the inferior obliques so as to bring similar parts of the retinæ under the dissimilar images, resulting in binocular single vision.

When there is equality of strength of the obliques of the two eyes, vertical and horizontal astigmatism will give less trouble than when the astigmatism is oblique in either direction, and astigmatism with the meridians of greatest curvature diverging above need give no more annoyance to the patient than if these meridians converged above when the plane of vision is horizontal; for, in the former case, the superior obliques would be as able to bear the strain as would the inferior obliques in the latter condition. When the meridians of greatest curvature diverge above and the plane of vision (visual axes) is directed down, as in reading, the added strain on the superior obliques would give more annoyance than if, in the same patient, the

meridians of greatest curvature converged above, for the reason that, in the latter, the simple action of the superior obliques to overcome the tendency to outward rotation of the eyes by the inferior recti would, to that extent, relieve the tension of the inferior obliques excited by the astigmatism.

But the obliques are not always harmonious. The superior obliques are insufficient in at least 25% of all cases, while the inferior obliques are insufficient in less than 1% of all cases. In cases of insufficiency of the superior obliques the vertical form of astigmatism would be worse on the patient than if he had oblique astigmatism with the meridians of greatest curvature converging above; and the worst form of astigmatism would be that in which the meridians of greatest curvature diverge above. The reverse would be true if the inferior obliques were insufficient—a rare condition.

The complicated function of the oblique muscles exists alone in cases of oblique astigmatism with meridians of greatest curvature converging or diverging, and in unequal degrees of oblique astigmatism when the meridians of greatest curvature are parallel. The necessity for this function is entirely destroyed when the astigmatism is properly corrected; but the action of the obliques does not always cease at once in binocular single vision through the correcting cylinders. The old habit of rotation often continues for hours and sometimes for days, although there is no longer a need for it, and the result is metamorphopsia. Inherent weakness of the superior oblique muscles, in a large percent. of the cases, leads to a more speedy disappearance of the metamorphopsia when the meridians of greatest curvature diverge above than when they converge. The reverse would be true in a case of insufficiency of the inferior obliques. The *habit* of action is more quickly suspended in a weak muscle than in a strong one. In all cases, however, it ceases, and the metamorphopsia vanishes, under the continuous wearing of the correcting cylinders.

Artificial conditions may excite the obliques into the performance of either their simple or complicated function, depending on the means used. A prism placed, base up, before one eye would call into action the inferior rectus of that eye. This action would tend to turn the vertical meridian out above, which tendency would be at once counteracted by action of the superior oblique so as to keep that meridian parallel with the vertical meridian of the fellow eye. A prism, with base up, before the right eye, and one with base down, before the left would call into action the inferior rectus of the right and superior rectus of the left and there would be an associated and corrective action of the superior oblique of the right and inferior oblique of the left, if the vertical meridians are to be kept vertical. In this case, however, the naturally vertical meridians being still parallel, though not vertical, are most likely allowed to remain tilted since diplopia would not result.

Prisms placed, bases out, before the eyes will call into action the internal recti, in obedience to the law of corresponding points. If these muscles are attached neither too high nor too low, other muscles will not be affected by the prisms; but if these muscles are attached too low, their forced action will tend to make the naturally vertical meridians diverge above, when a corrective action of the superior obliques becomes necessary; or if the attachment is too high, the inferior obliques act to prevent the convergence of the vertical meridians above. The indirect effect on the oblique muscles, of prisms in position of rest for weak recti muscles, may account largely for the unsatisfactory results of that once common plan of treatment.

In the rhythmic exercise treatment of the internal recti muscles, a state of insufficiency of the superior obliques is sometimes developed that was not manifest in the beginning even under the proof test. The only explanation is that the internal recti, in these cases, are attached too high and their exercise has been necessarily associated with corrective rhyth-

mic action of the inferior obliques so that they become too strong for the superior obliques. These cases do not improve as they should until proper attention is given to the superior obliques. In only two instances have I seen insufficiency of the inferior obliques develop as a result of exercise of the interni; and it is easy to suppose that, in these cases, the interni were attached too low and that, consequently, their exercise was associated with corrective rhythmic contraction of the superior obliques, resulting in their hyperdevelopment. These cases did not do well until attention was given to the inferior obliques, in connection with the treatment of the interni.

The effect of prisms on the externi, under conditions of too high or too low attachment, would bring about a secondary effect on the obliques, precisely as has been described in connection with the interni. In either case the obliques are performing their simple function, that of keeping the naturally vertical meridians parallel.

The complicated function of the obliques may be excited by artificial means also. As already stated, artificial oblique astigmatism calls into harmonious, symmetric activity either the superior or inferior obliques, depending on the divergence or convergence above of the meridians of greatest curvature.

In the correction of any form of astigmatism the proper location for the axis of the cylinders should always be determined, as a variation in either direction would throw strain on the oblique muscles which would be badly borne in proportion to the strength of the displaced cylinders and the extent of their deviation. Several curious facts may be brought forward here; and reasons can be given why advantage should be temporarily taken of these facts in certain cases. Fig. 1, in Plate IV, represents a pair of hypermetropic astigmatic eyes, the meridians of greatest curvature being vertical in each eye. The plus cylinders, axes 90° (a), insure against strain of either the superior or inferior obliques; but let the glasses be turned in the rims

so that the axis of the right shall stand at 80° (b) and the axis of the left, at 100° (b), images will be distorted as shown in

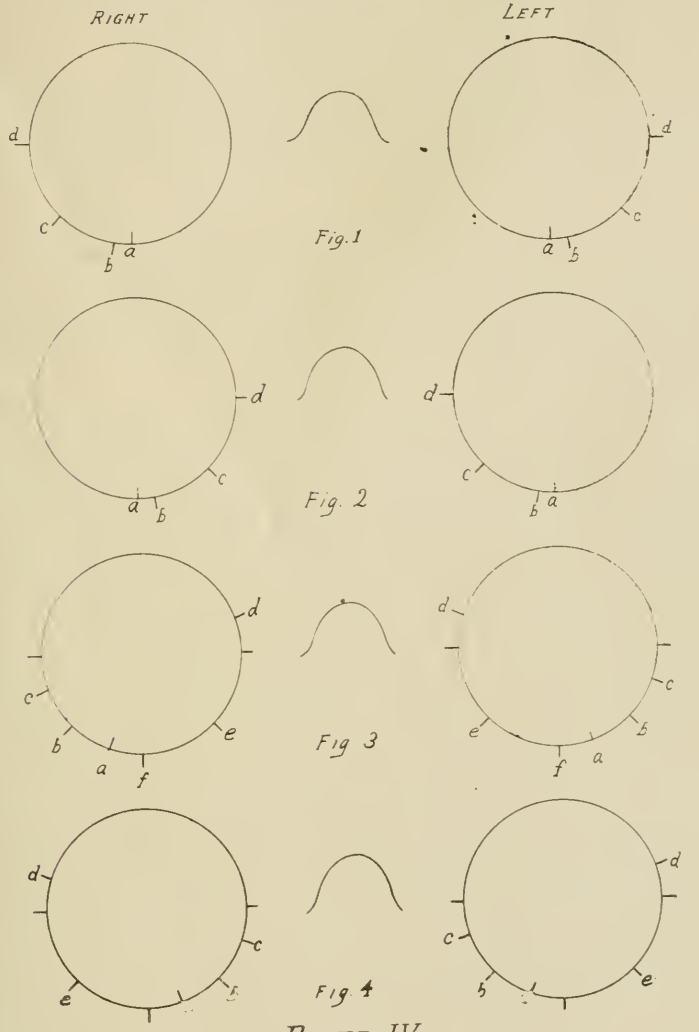


PLATE IV

Plate II, which would necessitate strain on the part of the superior oblique muscles. The distortion of the images would increase, and the strain on the superior obliques would be greater, as the axes are revolved further away from the vertical,

the maximum being reached at 45° (c) for the right and 135° (c) for the left eye. Passing these points the distortion grows less until at 180° (d) for each eye, it disappears.

Fig. 2 represents the same pair of eyes. If now the axis of of the right cylinder should be revolved from 90° (a) to 100° (b) and that of the left from 90° (a) to 80° (b), the distortion of images would be such as to call into activity the inferior obliques so that there might be binocular single vision. This distortion would reach its maximum when the axis of the right cylinder stands at 135° (c) and that of left at 45° (c), again lessening as the axes are made to approach the horizontal, where the distortion ceases.

Fig. 3, Plate IV, represents a pair of hypermetropic astigmatic eyes with the meridian of greatest curvature for the right at 70° (a) and that of the left at 110° (a). (In all the figures of plates IV, V and VI, the mark within the circle shows the location of the meridian of greatest curvature). These meridians converging above would cause strain on the inferior obliques, which would be relieved by the correcting cylinders, axis of right at 70° (a) and of left 110° (a). A revolution of the axis of the right cylinder to 45° (b) and that of left to 135° (b) would so displace the images as to call into action the superior obliques, the displacement increasing as the axes are moved until these points (b for each eye) are reached. Continuing the revolution of the cylinders in the same directions, the displacement lessens and disappears entirely when the axis of the right reaches 20° (c) and that of the left 160° (c), and the necessity for action of the obliques no longer exists. If the axes of the cylinders are moved from their correct positions (70° for right and 110° for left eye) to 90° (f) for each eye, images will be so displaced as to call into corrective activity the inferior obliques. The maximum of displacement would be effected when the axis reaches 135° (e) in right and 45° (e) in left eye. Continuing the revolution in the same directions the displacement

would grow less and finally disappear when the axis of right stands at *d*, and that of the left at *d*, each 20° above the horizontal. As will be seen the arc of distortion, so as to throw strain on the superior obliques, is 50° (from 70° to 20° in right eye, and from 110° to 160° in the left eye), while the arc of distortion that would throw strain on the inferior obliques is 130° (from a to d).

Fig. 4, Plate IV, shows the meridians of greatest curvature of these hypermetropic astigmatic eyes at 110° (a) for right and 70° (a) for left. These meridians diverging above would call into corrective activity the superior oblique muscles. Correctly chosen and properly placed cylinders, by correcting the distortion of the images, would remove the necessity for the performance of the complicated function of the superior obliques. Displacing the axes of these cylinders, the right to 135° (b) and the left to 45° (b) would cause a maximum of distortion of the images, of the kind to call into action the inferior obliques. Continuing the revolution of the cylinders, the distortion would disappear when the axis of right reaches 160° (c) and that of the left, 20° (c). Should the axes of the cylinders be revolved from their proper places (at 110° (a) in right and 70° (a) in left) to 90° (f) for each eye, the images would be so changed as to call into harmonious activity the superior obliques. The maximum distortion would occur when the axis of right is at 45° (e), and that of left, at 135° (e). Continuing the revolution the distortion would disappear when the axes reach the points *d* above the horizontal meridians. In this case the arc of distortion causing activity of the inferior obliques is 50° (from *a* to *c*) while the arc of distortion that would throw strain on the superior obliques is 130° (from *a* to *d*). If in this pair of eyes the meridians of greatest curvature had been at 130° for right and 50° for left, the arc of distortion that would call the inferior obliques into action would be only 10°, while the one that would cause activity of the superior obliques would be 170° (180° less 10°).

Fig. 1, Plate V, represents hypermetropic astigmatic eyes, the meridians of greatest curvature being at 180° (a) in each eye, a condition that, in itself, would not call either the superior or inferior obliques into activity. The correct plus cylinders, axes 180°, would sharpen the blurred but not distorted images. Displacing these axes in the lower temporal quadrants would so distort the images as to throw into action the superior obliques; and the maximum of distortion would be effected when the axes reached 45° (c) in right and 135° (c) in left eye. With the axes turned to 90° (b) there would be no distortion of images, though there would be blurring as in all cases of displaced cylinders.

Fig. 2, Plate V, represents the same pair of eyes shown in Fig. 1. The axes of the correcting cylinders revolved in the lower nasal quadrant would so distort images as to call into action the inferior oblique muscles, the maximum being effected when the axes stand at 135° (c) for the right and 45° (e) for the left eye, the distortion lessening as the axes approach, and disappearing altogether when they reach, 90° (d.)

A comparative study of Figs. 1 & 2 of Plate IV, with Figs. 1 & 2 of Plate V, will show that, in hypermetropic astigmatism with the meridians of greatest curvature either vertical or horizontal, a revolution of the axes of the cylinders in the lower temporal quadrant will distort images (as of a rectangle) down and in and thus will call into harmonious ation the superior obliques; and it will also show that a revolution of the cylinders in the lower nasal quadrants will so displace images as to call into harmonious action the inferior obliques.

Fig. 3, Plate V, represents a pair of hypermetropic astigmatic eyes with the meridian of greatest curvature for right eye at 20° (a) and that of left at 160° (a). Since these meridians converge above the uncorrected condition would cause harmonious action of the inferior obliques. Properly chosen and correctly placed cylinders, axis at 20° a) for right and 160° (a) for left

eye, would relieve the distortion of the images and do away with the necessity for the complicated function of the obliques. Revolving the axis of the right cylinder from 20° (a) to 45° (b) and

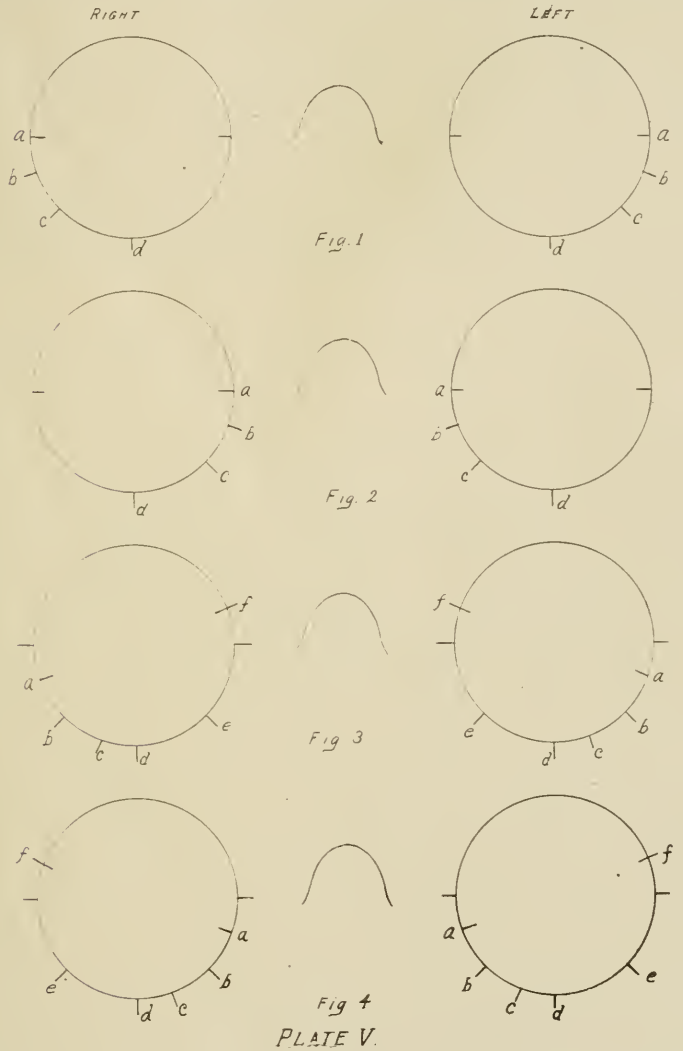


PLATE V.

that of the left from 160° (a) to 135° (b) would cause a maximum displacement of images in such a way as to call into action the superior oblique muscles, the distortion disappearing when

these axes reach 70° (c) for right and 110° (a) for left eye. Passing 70° (c) in right and 110° in left, the distortion becomes reversed so that strain will be thrown on the inferior obliques, the maximum being attained when the axis of the right stands at 135° (e) and that of the left at 45° (e). The distortion decreases as the axes are still further turned in the same directions and disappears at the end of the arc of 130° (from *c* to *f*) when they coincide with the meridians of greatest curvature. Thus the arc of distortion involving the superior obliques is 50° (from *a* to *c*) while that involving the inferior obliques is 130° from *c* to *f*).

The eyes (hypermetropic astigmatic) represented by Fig. 4, Plate V, have their meridians of greatest curvature at 160° (*a*) in the right and 20° (*a*) in the left. These meridians diverging above would result, in the uncorrected case, in calling into harmonious action the superior obliques. Proper cylinders with the axis of right at 160° (*a*) and that of left at 20° (*a*) would correct the distortion of the images and relieve the strain on the superior obliques. A turning of these cylinders in the arcs *a-c* would distort the retinal images so as to bring into action the inferior oblique muscles, the maximum distortion existing when the axes are at *b*. Continuing the revolution from *c*, the distortion becomes reversed and as a consequence the superior obliques are brought into activity, the maximum being attained when the axes reach *e*. As the axes are revolved further the distortion lessens and finally disappears when they stand at *f* again coinciding with the meridians of greatest curvature. In this pair of eyes the arc of distortion involving the inferior obliques is 50° (from *a* to *c*) while that involving the superior obliques is 130°, the maximum of distortion in both instances being attained when the half way point of the arc is reached by the axis of the cylinder.

A comparative study of any two, or of all, the Figures in Plates IV and V, will show that the arc of distortion, by cor-

rective plus cylinders, involving the superior obliques, is always in the lower temporal quadrant wholly or in greater part, and if entirely within this quadrant, its length is always twice the distance from the meridian of greatest curvature to the 45° point of the quadrant, the other half being on the opposite side of the latter. In like manner it will be seen that the arc of distortion involving the inferior obliques by a revolution of plus cylinders is always in the lower nasal quadrant wholly or in greater part, and if entirely within the quadrant, its length is twice the distance from the meridian of greatest curvature to the 45° point of the quadrant, the other half being on the opposite

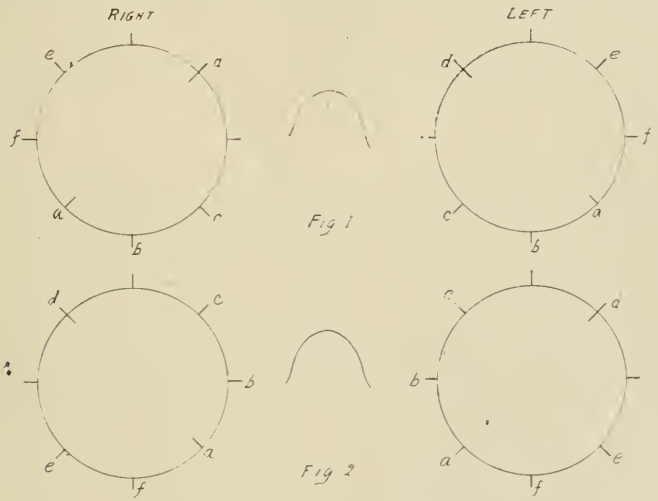


PLATE VI

side of the latter. When the arc of distortion involving the superior obliques is 90° that involving the inferior obliques is 90° and *vice versa*. When the arc of distortion involving the superior obliques is less than 90°, the arc involving the inferior obliques is always the difference between the former and 180°, and *vice versa*. The maximum of distortion is always attained when the axis of the cylinder is at the half way point of the arc.

Fig. 1, Plate VI, represents a pair of hypermetropic astigmatic eyes, the meridian of greatest curvature of the right at 45° (a) and that of left at 135° (a). These meridians converging above would cause such distortion of images as to throw into harmonious action the inferior oblique muscles. The proper cylinders correctly placed—axis of right at 45° (a) and axis of left at 135° (a)—would counteract the distortion and relieve the inferior obliques of the necessity of acting. Revolving the axes of the correcting cylinders in either direction would so distort images as to call into harmonious action the inferior oblique muscles. Since the arc of distortion for the superior obliques in this case is nothing, the arc of distortion for the inferior obliques is 180, from *a* to *d* in either direction, the maximum of distortion being attained respectively at *e* above an at *c* below.

Fig. 2, Plate VI, represents a pair of the same kind of eyes but with the meridian of greatest curvature at 135° (a) for the right and 45° (a) for the left. These meridians diverging above, the refraction is such as to distort images so as to call into harmonious action the superior obliques. As in the other case, the correct cylinders properly placed counteract the distortion and relieve the superior obliques from action. Rotating the axes of these cylinders in either direction from *a* would so distort images as to call into activity the superior obliques. In this case the arc of distortion for the inferior obliques is nothing and therefore the arc of distortion for the superior obliques is 180, from *a* to *d* in either direction, the maximum being attained at *c* above and *c* below.

A careful study of Plates IV, V, and VI, is fraught with practical importance. In all cases the exact location of the meridian of best (greatest in hypermetropic astigmatism) curvature should always be sought for with the greatest care, and may always be found; and the lens should be cut so that its axis may coincide with this meridian, although, as will be

shown further on, it may not always be best to so place it, at first, in the frames. Based on the teachings of my paper on the "Harmonious Symmetric Action of the Oblique Muscles in Oblique Astigmatism," published more than three years ago, Dr. N. C. Steele, of Chattanooga, Tenn., U. S. A., formulated a perfect working rule for determining the position of the best meridian in hypermetropic astigmatism, there being in the given case no insufficiency of either oblique muscles. The fellow eye being covered, the eye under examination, no longer being dominated by the law of corresponding points, is likely at times to roll into the easy position (naturally vertical meridian becoming vertical) by a relaxation of the muscles accustomed to overacting in binocular single vision. This, of course, would cause the meridian of greatest curvature to slightly vary its position, the variation being in proportion to the amount of obliquity of the astigmatism and the quantity, but rarely, if ever, amounting to more than 5°. If the best meridian is in the lower temporal quadrant and there is doubt between two points 5° apart, the axis of the plus cylinder should be placed at the higher, if the best meridian is in the lower nasal quadrant and there is doubt between two points 5° apart, the axis of the plus cylinder should likewise be placed at the higher point. Steele's rule in all cases of oblique hypermetropic astigmatism is: "In those cases in which the axes of the proper cylinders for the two eyes diverge above, place the cylinders at those points which will give the axes the greatest divergence permitted by the tests, and in those cases in which the axes converge above, place them at the points which will give them the greatest convergence permitted by the tests."

While the above rule, in cases free from insufficiency of the oblique muscles, is a perfect one, so far as finding how the lenses should be cut is concerned, it is not, even in these cases, the rule to be followed in the immediate placing of the lenses in the frames. After a time, however, the cylinders cut according to the Steele rule should be so placed permanently.

In the case represented by Fig. 3, Plate IV, since the meridians of greatest curvature converge above, the inferior obliques have always been accustomed to over-acting while the superior obliques have to the same extent been accustomed to doing less work than would have been required of them in eyes free from oblique astigmatism. Placing the axis of right cylinder at 70° (a) and that of left at 110° (a) would at once take away the cause for over-action on the part of the inferior obliques. The necessity for work so suddenly taken from them is just as quickly transferred to the superior obliques, and as a result, in most cases, there is either suffering excited, the superior obliques responding to the new demand, or there is metamorphopsia, these muscles rebelling, for the time, against the new conditions brought about by the cylinders. Both the suffering and the metamorphopsia may be avoided by revolving the cylinders in the rims so that their axes are made to traverse the arc (a-d) of distortion for the inferior obliques to the extent of 5° to 10°. The distortion will create the necessity for action on the part of the inferior obliques of the kind to which they have always been accustomed. Since the cylinders are made to describe larger arcs than the meridians of greatest curvature are made to traverse by the action of the inferior obliques, there will not be coincidence of the axes of cylinders and meridians of greatest curvature, and vision will to that extent be blurred, though sharper than if no cylinders were on. Beginning with the cylinders thus displaced they should be revolved 1° or 2°, every second or third day, back towards the equilibrium positions of the meridians of best curvature. Each backward move will take away part of the necessity for strain of the inferior obliques, transferring the same quantity of strain to the superiors. Thus by degrees the work is transferred from the inferior obliques to the superiors, and that, too, without exciting either discomfort or metamorphopsia. In this case it would be a serious mistake to displace the axes in

the arc (a-b) of distortion for the superior obliques; for, to the work transferred from the inferior to the superior obliques, there would be added the contraction necessary to harmonize the distorted images.

In like manner it could be shown that the axes of the cylinders for correcting the astigmatism represented in Fig. 4, Plate IV, should be temporarily placed 5° or 10° from their permanent places in the arcs (a-d) of distortion for the superior obliques. As in the case represented by Fig. 3, Plate IV, the axes should be gradually revolved back to their permanent resting-place.

In any case of oblique astigmatism with the meridians of greatest curvature converging above (see Fig. 3, Plate IV, Fig. 3, Plate V, and Fig. 1, Plate VI), there being no insufficiency of the inferior obliques, the axes of correcting cylinders should be temporarily displaced 5° or more within the arcs of distortion for the inferior obliques, and gradually revolved back to their proper permanent points. Since there is no arc of distortion for the superior obliques in the eyes shown in Fig. 1, Plate VI, the temporary displacement may be either up or down from *a*.

In any case of oblique astigmatism with meridians of greatest curvature diverging above (see Fig. 4, Plate IV, Fig. 4, Plate V, and Fig. 2, Plate VI) there being no insufficiency of the superior obliques, the axes of correcting cylinders should be temporarily displaced 5° or more in the arcs of distortion for the superior obliques, the backward change being effected by degrees so as to gradually transfer work from one muscle to the other. Since there is no arc of distortion for the inferior obliques in the eyes shown in Fig. 2, Plate VI, the temporary displacement of the axes may be either above or below the points *a*.

So, far in speaking of the arcs of distortion for obliques muscles, plus cylinders have been in mind. When minus cylin-

ders are required, what would be the arc of distortion for the superior obliques, if plus cylinders were used, becomes the arc of distortion for the inferior obliques, and *vice versa*.

Unfortunately there is not always perfect equilibrium of the oblique muscles in oblique astigmatic cases. If, as is most common, there is insufficiency of the superior obliques, oblique astigmatism with meridians of greatest curvature converging above will give but little trouble as compared with astigmatism in which these meridians diverge above, and for the very good reason that in the former there is harmonious strain on the strong inferior obliques while in the latter there is harmonious strain on the weak superior obliques.

Uncorrected oblique astigmatism with meridians of greatest curvature converging above, associated with insufficiency of the superior oblique muscles, is far more endurable than is the most perfect correction of the astigmatic error that can be made, when the insufficiency itself is ignored. On the other hand, when insufficiency of the superior obliques complicates oblique astigmatism with the meridians of greatest curvature diverging above, the correcting cylinders give immediate relief and become a joy forever.

If it is important in cases of oblique astigmatism, not associated with insufficiency of the superior obliques, to temporarily displace the axes of the cylinders in the arcs of distortion for the inferior obliques, it becomes doubly necessary to do so when there is insufficiency of the superior obliques as a complication; and if these axes are ever to be revolved back so that they shall coincide with the proper principal meridians, the weak obliques must be first developed by exercise.

There is another, and very proper method of correcting oblique astigmatism, especially that form in which the meridians of greatest curvature converge above. As already pointed out, the distortion of images (meridians of greatest curvature converging) is such as to throw strain on the inferior ob

lique muscles. A partial (say 1-4) correction of the astigmatism will slightly relieve the distortion of the images and will thus transfer one fourth of the strain from the inferior obliques to the superior obliques. Having used the quarter correction for a few days, a half correction might be given, when another fourth of the distortion of images is relieved and a proportionate amount of strain is again transferred from the inferior to the superior obliques. After another period of a few days a three quarter correction could be given and so on to the full correction, thus gradually giving the patient full acuity of vision, and as gradually transferring work from the inferior to the superior obliques.

DERMATITIS (PSEUDO-ERYSIPELAS) PERIOCULARIS MEDICAMENTOSA.*

By DR. EDWARD FRIDENBERG,
Ophthalmic and Aural Surgeon to the German Hospital, New York.

On November 17th, 1893, I was called to see B. S., a girl aged eleven. Her right eye had been red and somewhat painful for a few days, and an oculist had prescribed drops which proved to be a ½% watery solution of atropine sulphate and hot applications. Shortly after using the drops, the eye and surrounding tissues became swollen and tender, but treatment was continued. I found the patient apparently a healthy girl. The lids of the right eye and the cheek as far down as the angle of the mouth were swollen, edematous, reddened, and painful on pressure, the conjunctiva injected and slightly chemotic. The iris was fairly well dilated. There was considerable circumcorneal injection. The original condition was evidently an iritis. Later on it was shown to be a heredito-syphilitic kerato-iritis. The periocular inflammation, which closely resembled a commencing erysipelas, was diagnosed as a form of atropine intoxi-

*Read before the Ophthalmological Section of the N. Y. Academy of Medicine.

cation, and the atropine collyrium was stopped, a solution of boric acid being substituted, and a cooling ointment prescribed. Five days later the swelling and redness had disappeared without desquamation: but the iris had contracted and was adherent to the lens-capsule. The necessities of the case and the opportunity to test the various mydriatics as to their local toxic action, led me to instil them as follows at different times:

1st. Cocaine in 5% solution without apparent effect. Two drops of a 3% solution of atropia alkaloid in castor oil dilated the pupil ad maximum and reproduced erysipelatous inflammation of the lids and cheek within eighteen hours; redness, edema and tenderness disappeared in about four days. One drop of a 10% watery solution of Duboisine sulphate (instilled by mistake instead of the 1% solution), caused a marked constitutional poisoning, characterized by wide dilatation of both pupils, much thirst, flushing of the entire surface, dizziness, numbness of the extremities, rapid pulse, delirium, and extreme talkativeness, but no local symptoms. 1% Duboisine solutions and 2% Homatropine solutions repeatedly instilled were not followed by either local or constitutional symptoms, beyond the dilatation of the pupil.

In looking over the literature of these cases I found that they were frequently thrown into the same category with atropine-conjunctivitis, which fact, together with the comparative rarity of this condition must serve as a justification of my paper.

Atropine conjunctivitis is a condition only observed after a prolonged local use of the drug (weeks or months), and is usually characterised by the formation of follicles in the lower cul-de-sac, and by slight blepharitis. The pseudo-erysipelas, on the contrary, is observed after a single instillation of even a weak solution of various mydriatics. It is characterized by an inflammatory edema of the lids and cheek occasionally with the formation of vesicles. If the instillation be persisted in the inflammation may spread over the face and down the neck;

the infiltration becomes brawny and constitutional disturbance, (chills and fever) are marked. (cf. article by Dr. Jul. Donath, in *Wiener Med. Wocherschrift*, 1880, No. 12, p. 313). The symptoms gradually disappear in from four to seven days after the last instillation. One of the first, if not the first, cases of this kind was observed by Dr. H. D. Noyes. (R. L. *Opth. Hosp. Rep.*, 1869, Vol. VI., Part 3, p. 209). The patient, a man aged sixty-one years, had used a very dilute solution of atropine for many months. A 2 gr. solution was instilled to facilitate ophthalmoscopic examination. "Next day," says the author, "there was a smart conjunctivitis with erythema of cheek and lids. The patient told me he was used to this, that such was always the effect of atropine, and he used a dilute solution of iodine to control it. In a few days the attack passed away. After an operation a mydriatic was needed. Daturine was almost as irritating as atropine. Finally a 4 grain solution of hyoscyamine was found to be tolerated. The employment of extract of belladonna to the forehead caused erythema as readily as atropine in the eye.

Other mydriatics occasionally have similar effects. G. M. Gould (on a case of homatropine susceptibility, *Philadelphia Medical News*, Jan. 21, 1893), relates the following case: "I lately had a patient, a lady about thirty years of age, who showed an extreme idiosyncrasy as regards homatropine. For purposes of mydriasis, I dropped into each conjunctival sac a tiny drop of a solution (Merck's manufacture), gr. viii ad oz. i, four times, at intervals of from five to ten minutes. I habitually instil only a portion of a full-sized drop, by extruding this amount at the end of the dropper, and lightly touching the conjunctiva with it. The entire eight droplets would consequently not equal more than one or two of the usual size. In consideration of this fact, and also deducting the amount wiped away with tears or otherwise not absorbed, the total quantity of the drug absorbed must have been infinites-

inally small. The following morning the patient's lids were swollen almost shut, and the cheeks for two inches below the eyes were puffy and highly discolored; the skin of the back, chest, arms, and legs was erythematous, and there was general prickly heat with great itching. The effects passed off in twenty-four hours. The patient informed me that similar symptoms had several times resulted from the use of belladonna plasters."

E. Treacher Collins (R. L. O. H. Reports, 1888, July, p. 164), under the heading "Atropine Irritation," describes a case of swelling of the lids and conjunctival injection in a man aged fifty-six, after one drop of a 2 gr. atropine solution, in which Duboisine also caused irritation; and another of swelling and redness of lids, and conjunctival injection in a woman aged sixty-nine after one drop of a 2 gr. atropine solution, which disappeared while hyoscyamine gr. ii solution was used, but reappeared after an instillation of Duboisine, 2 gr. solution.

The effect of daturine was noted in Noyes' case above detailed E. Gruening (oral communication), saw this condition following an instillation of cocaine in a man aged thirty-four, who had just recovered from a pseudo-erysipelas, due to the use of atropine. That no cases have yet been observed (or at least published), after Hyoscine and Hyoscyamine, is probably due to the restricted local use of these mydriatics.

The term pseudo-erysipelas seems to me to be justified by the local appearances. In fact this very condition has been diagnosed and treated as true erysipelas by competent observers. Thus Lawson (Royal Ophthal. Hosp. Rep., 1869, vi, p. 119), instilled a $\frac{1}{5}\%$ atropine solution into the pupil of a patient, in whose eye some soft lenticular matter had remained after cataract operation. The eye became very painful with the lids swollen, and on the following day a distinct *erysipelatous* blush was seen over the lids and extending down the face. He says, "As I have never seen *erysipelas* following the extraction of an opaque lens or the use of atropine in the eye, I regarded its occurrence as an acci-

dental circumstance, but as the drops gave pain they were stopped, and a lotion of the extract of belladonna was substituted. The *Erysipelas*, however, increased, spreading over the head and forehead and down the face. The belladonna lotion was shortly afterward discontinued, as with the swelling of the lids it was not only useless but seemed to give pain. All the severe symptoms now abated, and the patient soon recovered, but with the pupil closed by opaque capsule. About six months afterward the gentleman called on me at my house, as I wished to examine the eye previous to performing a needle operation. In order to ascertain how much the pupil would dilate, I dropped into the eye two drops of a solution of atrop. sulph. gr. ii ad aq. oz. i. I had not at that time connected erysipelas with the use of the belladonna, and was quite unprepared for the symptoms which were to follow. Very shortly after I had put the atropine in the eye he complained of pain, which steadily increased, and about four hours afterwards the lids began to swell, and a distinct erysipelatous blister showed itself. By the following morning he was unable to open the lids on account of their swollen state, and there was a diffuse form of erysipelas extending from the lids over the brow and face. . . . In this patient the relationship between the cause and effect was so manifest that there could be no doubt that the *erysipelas* was solely due to atropine."

Julien J. Chisolm (*Maryland Med. Journal*, 1881–2, p. 375. A singular case of hostility to the local use of atropine and duboisine, the first causing facial erysipelas, the second, temporary insanity in a patient seventy years of age) treated the irritation following atropine instillation as facial erysipelas with tinct. of iron twice. After a third attack the causal connection was recognized. Desquamation followed each attack. Duboisine (4 gr. sol.) was freely used with no local symptoms. After appreciating the singular phenomena induced by the local action of atropine, he tested its irritation repeatedly and

brought on swelling of the lids and cheek by a single instillation of a 1% solution of the sulphite of atropine.

Wallace (*University Med. Magazine*, Philadelphia, Pa., 1892, rep. in Sajous) reports a case, where a drop of atropia solution introduced into the eye to correct astigmatism, produced an *erysipelatous* inflammation of the eyelids and face.

W. J. Tyson Folkestone (*Brit. Med. Journal*, Oct. 26, 1889), says, "I have seen erysipelatous skin affections of the face following local applications of atropine to the eyes."

Williams (rev. in Hirschberg's Centralblatt, Aug. 1888, p. 109) describes an "erysipelatous" inflammation and swelling of the skin resulting from the use of atropine.

The condition is further described as "herpes (following the external use of belladonna to an inflamed knee joint) with a good deal of swelling over the seat of the application," by Mackintosh, (*Brit. Med. Journal*, Oct. 17, 1885). Two months later the patient was ordered a solution of atropine for iritis. Some of the solution ran over the cheek (sic! and was in a few hours followed by a herpetic eruption of exactly the same character. The swelling was so great that the eye was completely closed.

Fialkowski (Hirschberg's Centralbl. Suppl. 1883, p. 319), speaks of it as erythema and eczema of the eyelids. Donath, (loc. citato) as erysipelatous redness of the lids and eczema of the face and neck.

Soelberg Wells (Handbook, London, 1870, p. 99), states: "I have seen instances in which a drop of a weak and quite pure solution of atropine has produced great irritation and pain or even an erysipelatous condition of eyelid and cheek, accompanied by redness and chemotic swelling of the conjunctiva."

As to the frequency of this peculiar condition, after a careful search through the literature of the subject, I have found but one case from homatropine, one from daturine, one from cocaine, and three from duboisine, (2 of Collins, v. supra, and one

of Schenkl. Prag. Med. Woch., 1880, No. 19, p. 181). Though more frequently observed afther atropine instillations, it is still very rare.

Hirschberg (Realencyplopædie gesammten Heilkunde, II, No. 2, 1885) speaks of it as "ueberaus selten," exceedingly rare and has apparently not met with a case himself. In the text-books of Noyes, 1892; Oliver and Norris, 1893; Schmidt-Rimpler, 1893, it is not described. DeSchweinitz, 1892, does not differentiate it from the ordinary granular atropine conjunctivitis. Fuchs (transl. by Duane 1892), 1889, notes its occurrence in some individuals, while P. A. Morrow, (Drug Eruption, 1887), refers to it as a clinical fact familiar to ophthalmologists.

Conclusions—Pseudo-erysipelas, a condition simulating true erysipelas, but not related to it either etiologically or pathologically is met with after the instillation of various mydriatics into healthy or diseased eyes. It may be induced by only one of this group of drugs or by several. It constitutes what we may call a local idiosyncrasy, not to be comfounded with the ordinary constitutional susceptibility to the action of mydriatics. This idiosyncrasy seems to be congenital in most cases. In Chisolm's case (v. supra) it was acquired. It apparently does not affect the gouty more frequently than any other class.

2019 Fifth Ave.

SECTION ON OPTHALMOLOGY, A. M. A., BALTIMORE MEETING.

Preliminary program of the Section on Ophthalmology of the American Medical Association for the Baltimore meeting:

1. Address of the Chairman, Edward Jackson, Denver, Colo.

2. Incipient cataract, by A. R. Baker, Cleveland, Ohio. Discussion opened by Bœrne Bettman, Chicago, Ill.

3. The Operation for secondary cataract, by J. W. Thompson, Kansas City, Mo.

4. The Operative treatment of immature and some forms of zonular cataract, by J. E. Weeks, New York, N. Y.

Discussion on Cataract opened by Bœrne Bettman, Chicago, Ill., and G. E. Frothingham, Detroit, at H. Knapp, N. Y.

5. Case of congenital ectopia lentis with diplopia by F. C. Hotz, Chicago, Ill.

6. Ectopia lentis, by F. B. Tiffany, Kansas City, Mo. Discussion on ectopia lentis opened by Harold Gifford, Omaha, Neb.

7. Symposium on plastic operations about the eye (a series of five minute paper):

(a) Skin grafting on the eyelids, by F. C. Hotz, Chicago, Ill.

(b) The restoration of the eyelids with sliding flaps, by W. C. Tyree, Kansas City, Mo.

(c) Practical points in anesthesia for plastic operations about the eye, by M. W. Zimmerman, Philadelphia, Pa.

(d) Transplantation of skin in plastic operatians on the eyelids, by Walter B. Johnson, Patterson, N. Y.

(e) Blepharoplasty without a pedicle, by Eugene Smith, Detroit.

(f) Transplantation of a strip of skin in intermarginal space of lids, by H. Knapp, N. Y.

(g) Some cases of restoration of eyelids by plastic operations with exhibition of patients, by Herbert Harlan, Baltimore.

Discussion opened by R. A. Reeves, Toronto, and Swan M. Burnett, Washington.

8. Symposium on operations on the ocular muscles (a series of five minute papers):

(a) The indications for and the advantages and technique of muscle shortening, by G. C. Savage, Nashville, Tenn.

(b) The slight effects sometimes produced as the results of free tenotomies of the ocular muscles for heterophoria, by S. Theobald, Baltimore, Md.

(c) The technique of tenotomy of the ocular muscles, by L. Connor, Detroit, Mich.

(d) The limitations of tenotomy of the ocular muscles, by H. F. Hansell, Philadelphia, Pa.

(e) Tendon advancement with a special indication for its employment, by C. H. Thomas, Philadelphia, Pa.

Discussion opened by G. T. Stevens, New York, and S. D. Risley, Philadelphia, Pa.

9. Hysterical affections of the eye muscles, by H. Gradle, Chicago, Ill.

10. Strabismus, by C. M. Hobby, Iowa City, Ia.

11. To what extent should recently suggested methods of muscular exercise displace tenotomy in the treatment of heterophoria, by Hiram Woods, Baltimore.

12. Some remarks on paralysis of the superior rectus muscle, by Ed. J. Bernstein, Baltimore.

13. Practical points gained in the treatment of one thousand cases of insufficiency of the ocular muscles, by J. W. Park, Harrisburg, Pa.

Discussion opened by J. F. Fulton, St. Paul; L. Connor, Detroit, and S. Theobald, Baltimore.

14. A new and almost bloodless enucleation operation, by Bœrne Bettman, Chicago, Ill.

15. Evisceration of the eyeball, by L. Webster Fox, Philadelphia, Pa.

Discussion opened by S. D. Risley and G. O. King, Philadelphia, Pa.

16. Histologic and bacteriologic notes on some cases of penetrating wounds of the eyeball, together with experimental observations on certain bacilli found in a case of post-operative panophthalmitis, by G. E. de Schweinitz, Philadelphia, Pa.

Discussion opened by R. E. Randolph, Baltimore, Md.

17. A clinical study of the ulcerative diseases of the cornea, by S. D. Risley, Philadelphia, Pa.

Discussion opened by C. J. Kipp, Newark, N. J.

18. The infiltration method of anesthesia in ophthalmic practice, with demonstration, by Harry V. Wurdemann, Milwaukee, Wis.

Discussion opened by Harry Freidenwald, Baltimore, Md., and Carl Koller, N. Y.

19. Report of committee on the scientific and hygienic value of examining the eyes in the schools, by B. Alex. Randall, Philadelphia, Chairman W. F. Southard, San Francisco, and others.

20. The use of prisms to increase vision in the formation of new maculæ in conical and leuchomatous corneæ, etc., by G. M. Gould, Philadelphia, Pa.

Discussion opened by T. H. Fenton, Philadelphia, Pa.

21. The percentage of symmetrical and a symmetrical meridiæ of the cornea in astigmatic eyes, by S. D. Risley, and J. L. Thorington, Philadelphia, Pa.

22. Two thousand five hundred cases of ocular headaches and the different states of refraction connected therewith, by W. F. Mittendorf, New York.

23. A study of the refraction of one thousand five hundred eyes, by H. Bert Ellis, Los Angeles, Cal.

24. Latent astigmatism, by W. H. Starkey, Chicago.

Discussion opened by W. H. Wilder, Chicago, Ill.

25. Anisometropia, by W. F. Southard, San Francisco.

Discussion opened by S. D. Risley, Philadelphia, Pa.

26. Some rare complications of infantile purulent conjunctivitis, by A. A. Hubbell, Buffalo, N. Y.

Discussion opened by B. Alex. Randall, Philadelphia, Pa.

27. Retrobulbar tumor, by S. C. Ayres, Cincinnati, O.

Discussion opened by J. A. White, Richmond, Va.

28. A case of enchondroma of the cartilage of the upper lid, by P. D. Keyser, Philadelphia, Pa.

29. Extensive changes in the choroid, with report of cases, by J. T. Carpenter, Jr., Philadelphia, Pa.

30. Anomalies in ophthalmic practice, by A. C. Corr, Carlinsville, Ind.

31. The relationship between eye and brain, by J. A. Lydston, Chicago, Ill.

32. Eight years' experience with the surgical treatment of trachoma, by H. Gifford, Omaha, Neb.

33. Hemorrhages into the retina and vitreous in young persons associated with evident disease of the retinal blood vessels; remarks on the formation of vessels into the vitreous and in a case of emigrating subhyaloid hemorrhage, by Harry Friedenwald, Baltimore, Md.

34. Formalin as a preservative agent of eye specimens, by W. H. Wilder, Chicago, Ill.

Discussion opened by F. C. Hotz, Chicago, Ill.

H. V. Wurdemann,
Secretary.

Since the above was put in type the following papers have been promised:

35. A new keratometer, by D. S. Reynolds, Louisville.

36. Ophthalmioplegia interna, by B. L. Milliken, Cleveland.

37. Observations upon the age of the negro with special reference to the refraction, ocular muscles, and color vision, by C. W. Kollock, Charleston, S. C.

38. On the general and local conditions that change corneal curvature, by L. J. Lautenback, Philadelphia.

39. Anisometropia by W. F. Southard, San Francisco.

40. Report of a case of traumatic varix of the orbit in which ligation of the left common caroted was performed, by C. A. Oliver, Philadelphia.

41. Some rare cases of infantile purulent conjunctivitis, by A. A. Hubbell, Buffalo.

42. Report of committee on legislation for the prevention of blindness, by Lucian Howe, Buffalo.

43. Extensive colloid changes in choriod, by J. T. Carpenter, Jr., Philadelphia.

44. Prognostic significance of albuminuric retinitis, by E. O. Belt, Washington.

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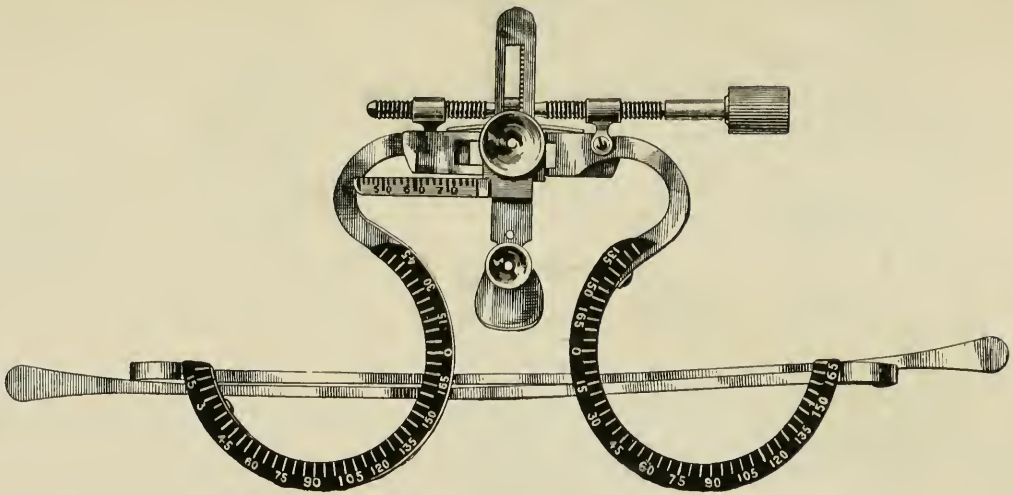

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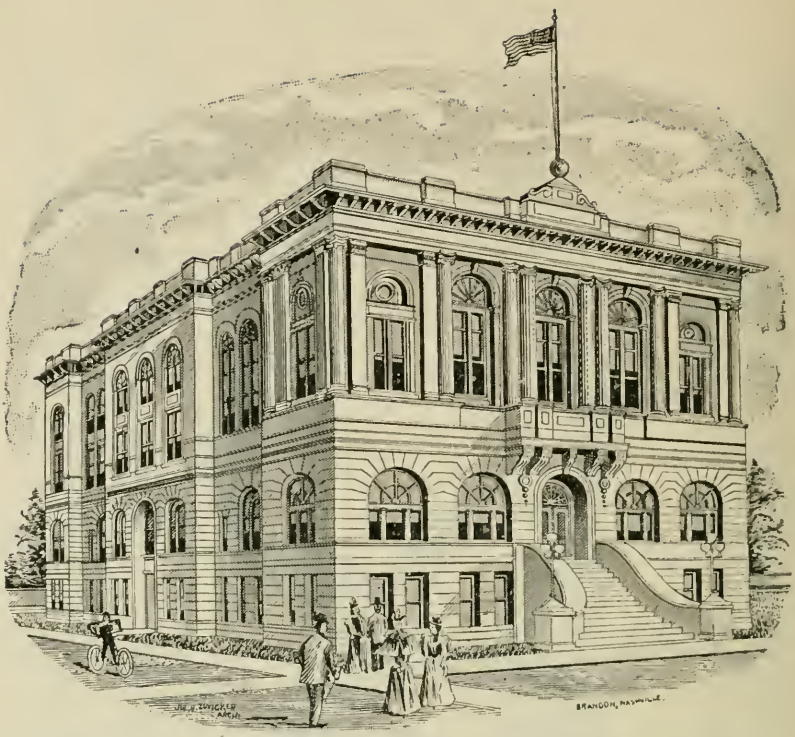

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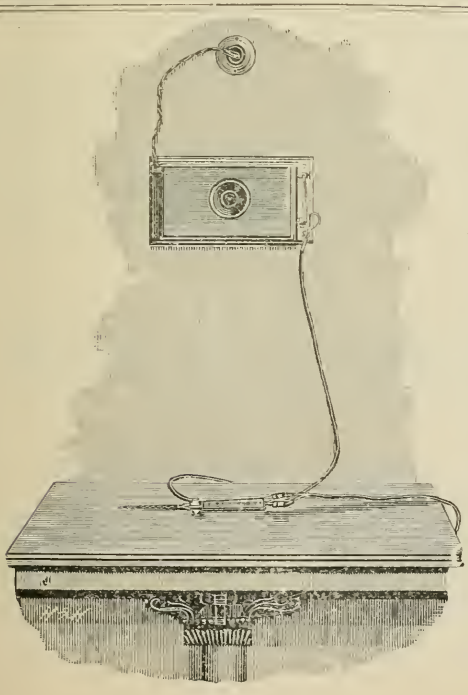

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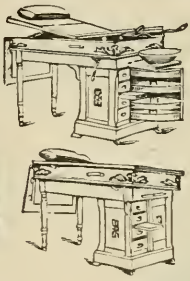

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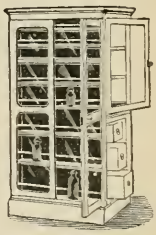

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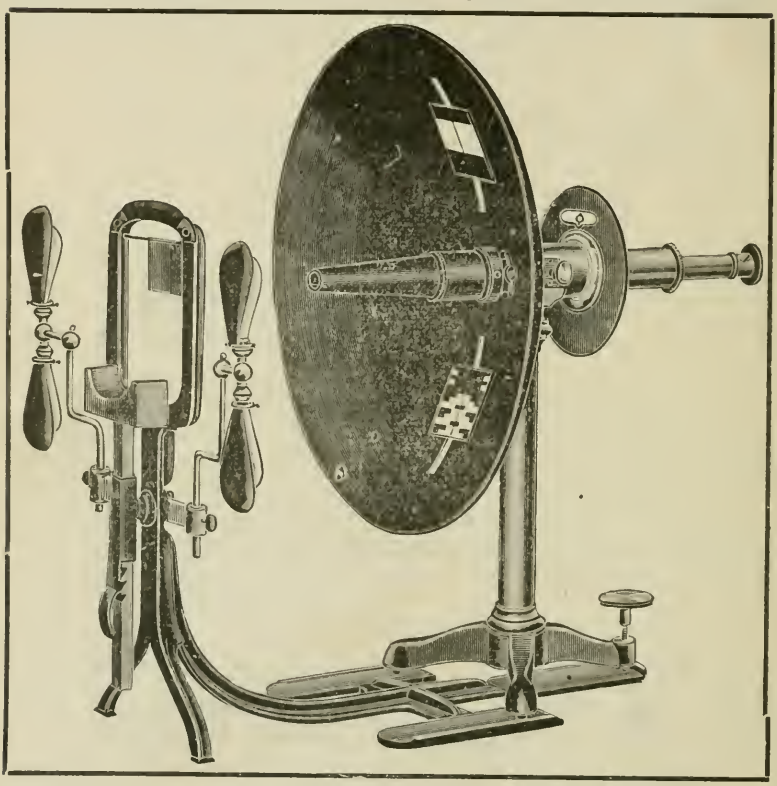

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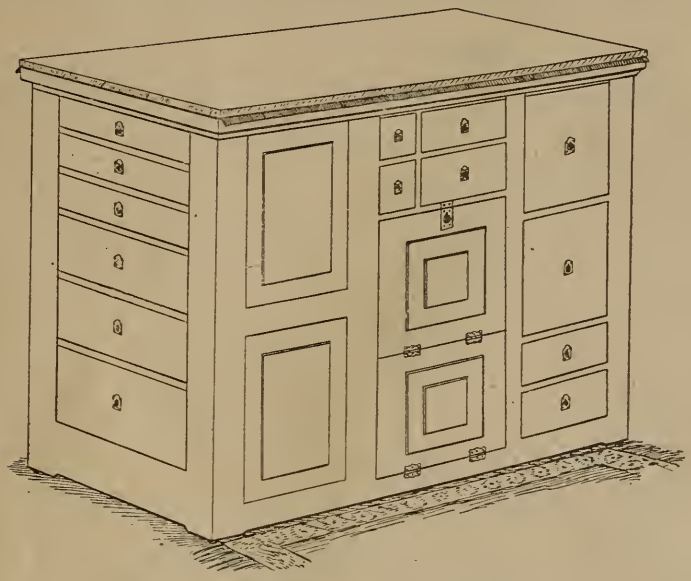

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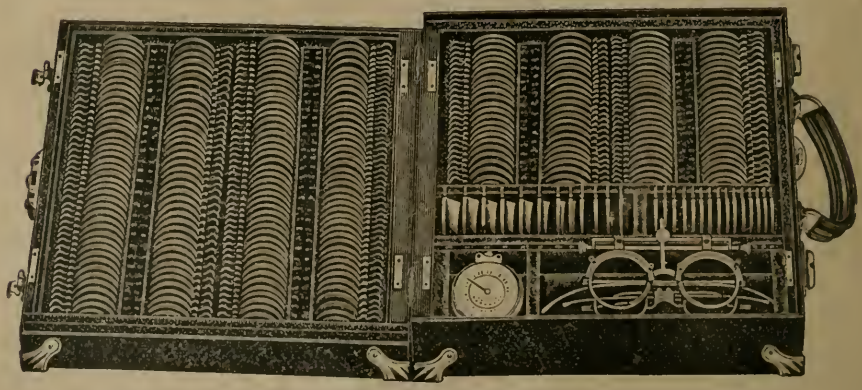

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